

THE BRACHIOPOD GENUS *CYCLOTHYRIS*

BY

ELLIS FREDERIC OWEN



Pp. 37-63; *Pls.* 4, 5; 10 *Text-figures*

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
GEOLOGY

Vol. 7 No. 2

LONDON: 1962

THE BULLETIN OF THE BRITISH MUSEUM
(NATURAL HISTORY), *instituted in 1949, is
issued in five series, corresponding to the Departments
of the Museum, and an Historical series.*

*Parts will appear at irregular intervals as they become
ready. Volumes will contain about three or four
hundred pages, and will not necessarily be completed
within one calendar year.*

*This paper is Vol. 7. No. 2 of the Geological
(Palaeontological) series.*

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THE BRITISH MUSEUM

Issued May, 1962

Price Fourteen Shillings

THE BRACHIOPOD GENUS *CYCLOTHYRIS*

By ELLIS FREDERIC OWEN

SYNOPSIS

A revision of M'Coy's genus *Cyclothyris* from the Upper Aptian is made and serial sections of the type-species presented for the first time. In addition eight other species of *Cyclothyris* are described, two of these are new species. The subfamily Cyclothyrinae of Makridin is emended and discussed. A comparison is made between *Cyclothyris* from the Lower Greensand and the Upper Chalk genus *Cretirhynchia*. A new generic name is proposed for five Lower Cretaceous Rhynchonellidae.

INTRODUCTION

THE name *Cyclothyris* was first used by M'Coy (1844 : 103) to indicate a group of brachiopods which he called "... those curious species in which the deltidium completely surrounds the foramen". No geological age was mentioned nor was any species named. M'Coy did, however, figure a specimen (p. 150, fig. 29) which is probably lost.

From the beak characters of Mesozoic and Palaeozoic Rhynchonellidae it seems likely that M'Coy was referring to an early Cretaceous genus and, from the arrangement of the costae, shell outline, growth-marks and interarea as seen in his fig. 29, it is probable that M'Coy had selected a specimen of Aptian age.



FIG. 1. Copy of M'Coy's (1844) original illustration of fig. 29, p. 150.

Previously, J. de C. Sowerby (1825 : 165, pl. 502, fig. 1) had described and figured a rhynchonellid from the Upper Aptian, Sponge Gravel of Faringdon, Berkshire under the name *Terebratula lata*. He subsequently changed this specific name to *T. latissima* in the index to the *Mineral Conchology* published in 1829, having realized that his father J. Sowerby (1815 : 227) had already used the name *T. lata* for a brachiopod from the Drift of Lowestoft, Suffolk.

The outline, arrangement of costae and growth-lines of J. de C. Sowerby's figured specimen of *Terebratula latissima* (pl. 502, fig. 1) agree with the figure of M'Coy's genus *Cyclothyris*. This similarity was certainly noted by Davidson (1855 : 93) who included *Cyclothyris* in his synonymy of Fischer's genus *Rhynchonella* and quoted *C. latissima* in brackets after the generic name, probably as a typical species of *Cyclothyris*.

Buckman (1906 : 326) was the first to designate *T. latissima* J. de C. Sowerby as the type species of *Cyclothyris* and subsequent authors have followed Buckman. The genus was not further investigated nor adequately defined until Hertlein & Grant (1944 : 61) published a full synonymy in their work on Caenozoic Brachiopoda from western North America.

Stratigraphically the genus ranges from the Upper Aptian to the Upper Cenomanian and was probably developed from such a middle European form as *Lepidorhynchia* which Burri (1956 : 689) described from the Neocomian, Lower Barremian, of

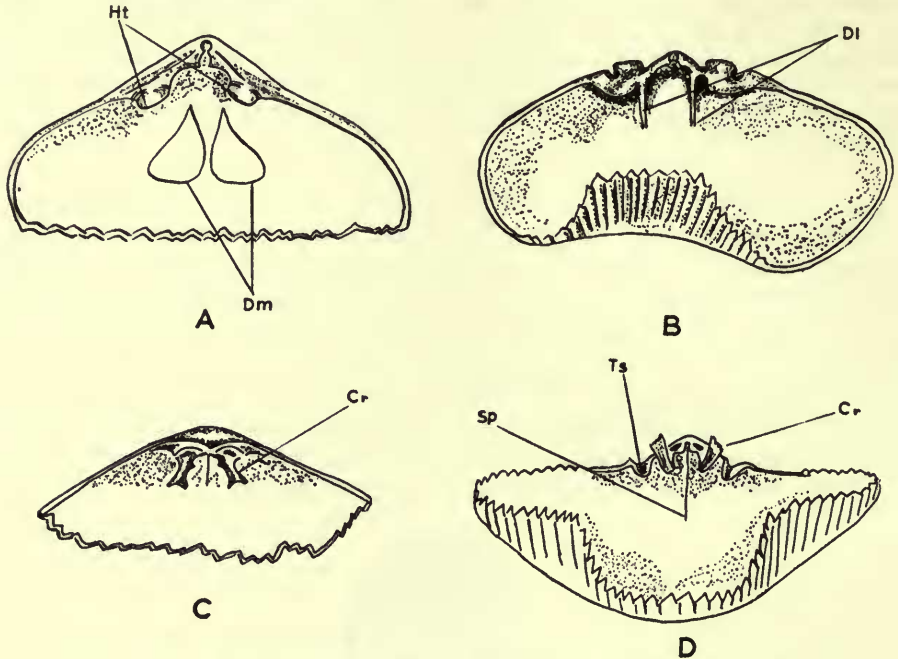


FIG. 2. Four drawings illustrating some of the internal characters of *Cyclothyris*. A. Pedicle valve showing subquadrate hinge-teeth (*Ht*) and large pear-shaped diductor muscle-scars (*Dm*). B. Subparallel dental lamellae in pedicle valve (*Dl*). C. Brachial valve showing ventral surface of the crura (*Cr*). D. Brachial valve showing the dorsal concave surface of the crura (*Cr*) and deep crenulated dental sockets (*Ts*) and short septum (*Sp*).

Switzerland. *Cyclothyris* appears to have been confined chiefly to the European continent, although a notable exception to this is *C. americana* described and figured by Cooper (1955 : 3, pl. 1) from the Aptian of Arizona. Examples of this species have not yet been examined by the writer but to judge from the figure on Cooper's pl. 1 it may well belong to this genus. Other species referred to *Cyclothyris* by Hertlein & Grant (1944 : 63) are probably not referable to the genus, but careful examination including the use of serial sections is necessary before any conclusions can be drawn. Another species from the American continent referred to this genus is *Cyclothyris* ? *subtrigonalis* Imlay from the Lower Neocomian of Mexico. This is shown in serial section (Imlay, 1937 : 571) to have a persistent septum in the brachial

valve and a large septalium, both characters which do not appear in serial sections of the type species *C. latissima* (J. de C. Sowerby).

In the English Aptian the genus is represented by at least four species namely, *C. latissima*, *C. depressa* (J. de C. Sowerby), *C. antidichotoma* (Buvignier) and *C. lepida* sp. n., but there may be others not yet investigated. The rhynchonelloid species "*R.*" *nuciformis* described from the Upper Aptian of Faringdon by J. de C. Sowerby (1825 : 166), and often erroneously referred to *Cyclothyris*, is probably related to a species described by the writer (Owen, 1960 : 253) as *Lamellaerhynchia larwoodi* from the Upper Aptian of Upware, Cambridge.

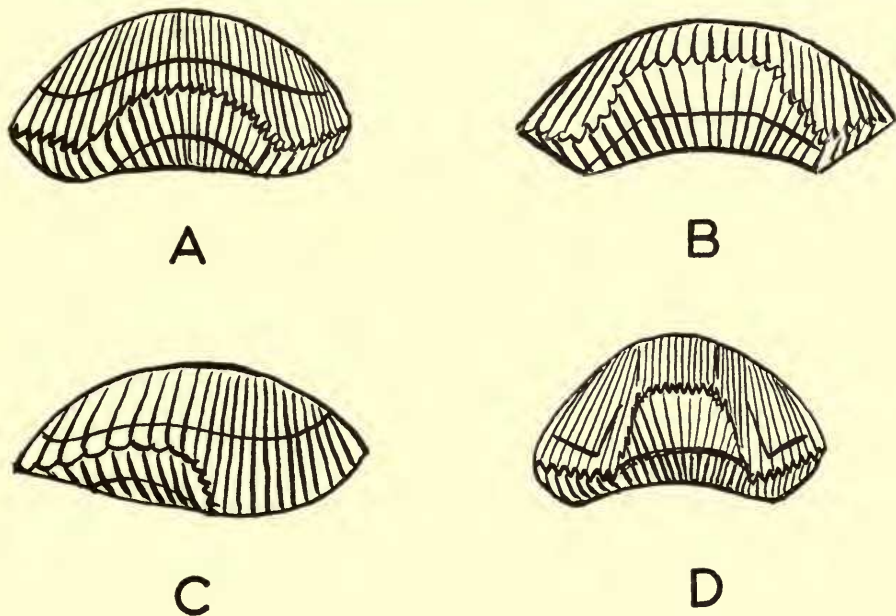


FIG. 3. Diagram illustrating different types of anterior commissure found in *Cyclothyris*.
A. Broadly arcuate. B. Trapezoidal. C. Asymmetrical. D. High arcuate.

Some of these Upper Aptian species are recognizable as passage forms in the Lower Albian deposits at Leighton Buzzard, Bedfordshire. Middlemiss (1959 : 138) regards the Shenley Limestone fauna as essentially of an Albian-Cenomanian type. While possibly true of the terebratuloid fauna it is certainly not of the rhynchonelloids. With the possible exception of two species the fauna is distinctly Albian, having close affinities with Upper Aptian faunas at Brickhill and Upware in this country and Lower Albian faunas at Grandpré, Haute-Savoie and Haute-Saône, France.

Two Lower Albian species of *Cyclothyris* are described here from the *Leymeriella tardefurcata* Zone of the Shenley Limestone of Leighton Buzzard, Bedfordshire. One is the widely quoted *C. antidichotoma* (Buvignier), which also occurs in the Upper Aptian, and *C. levis* sp. n.

By far the commonest Cenomanian species of *Cyclothyris* is *C. difformis* (Valenciennes in Lamarck) which ranges from the Lower to Middle Cenomanian. It has

been recorded from Wiltshire, Devon and Dorset in England and from Normandy in France, Tournai in Belgium, and Essen in North Germany. Examples of this species with its many varieties are to be found in the general collections of the British Museum (Natural History).

Apart from *C. difformis*, other Cenomanian species here described include *C. scaldensis* (d'Archiac) from the Tourtia of Belgium, and *C. schloenbachi* (Davidson), a common fossil in the Lower Cenomanian of Somerset and Devon.

The generic name *Burrirhynchia* is proposed for "*Rhynchonella*" *leightonensis* Walker from the Lower Albian, *L. tardefurcata* Zone of Shenley Hill, Leighton Buzzard, Bedfordshire. This genus is also represented in the Upper Aptian, *P. nutfieldensis* Zone, of Upware, Cambridge and Brickhill, Buckinghamshire by the species "*R.*" *cantabrigensis* Davidson.

An emended description of "*R.*" *leightonensis* together with serial sections were published by the writer (Owen, 1956 : 166, 167) and these may be compared with serial sections of *Burrirhynchia cantabrigensis* (Davidson) figured here as Text-fig. 10.

TERMINOLOGY

The terms used in the systematic descriptions here are according to Thomson (1927), Muir-Wood (1934) and Muir-Wood & Cooper (1960).

Cyclothyrid. As applied to the deltidial plates was proposed by the writer (Owen, 1956 : 165) to replace the term "*auriculate*" which was used by Buckman (1918 : 18) to describe the encirclement of the foramen by the deltidial plates.

Sulcus. The term *sinus* has often been used by authors to describe the median sulcation of a valve. Muir-Wood & Cooper (1960 : 8) pointed out that the term for this condition should be *sulcus*. Their definition was in connection with productoids, but the term is equally applicable to the rhynchonelloids and is quoted as "*Sulcus*.—A major depression in either valve usually median in position, which helps channel the outgoing stream in feeding. A median fold is usually opposite a median sulcus in the productoids."

The term *sulcus*, therefore, as defined by Muir-Wood & Cooper is used throughout the following systematic descriptions.

In the same publication Muir-Wood & Cooper (1960 : 14) redefined the following terms :

Capillae. Fine radial, elevated lines (with more than 25 in 10 mm.).

Costellae. Radial lines coarser than capillae (about 15–25 in 10 mm.).

In the following systematic descriptions the measurement of 10 mm. is taken to indicate a position 10 mm. wide at a distance 10 mm. anterior to the umbo on the brachial valve. These terms have been used as above in the descriptions of *C. antidichotoma*, *C. lepida* sp. n. and *C. levis* sp. n.

Dimensions of *Cyclothyris* specimens are given in millimetres but are defined generally as :

Small, measuring up to 15 mm. long, 20 mm. wide.

Medium, 16–28 mm. long, 21–38 mm. wide.

Large, 29–35 mm. long, 39–45 mm. wide.

SYSTEMATIC DESCRIPTIONS

Superfamily RHYNCHONELLACEA Schuchert, 1896

Family RHYNCHONELLIDAE Gray, 1848

Rzhonitskaya (1959), in an attempt to reclassify the rhynchonelloids, cited the subfamily Cyclothyridae which was proposed by Makridin (1955) for certain rhynchonelloid genera ranging from the Trias to the Cretaceous. Makridin's definition quoted by Rzhonitskaya is translated by Mrs. G. A. Cooper, Washington, U.S.A. as :
 " Ribbed or plicate rhynchonellids without a septalium ; septa may be developed or be absent, hinge-plate divided."

This very broad definition included such genera as *Stolmorhynchia* Buckman, 1914 and *Lacunosella* Wisniewska, 1932 which, unlike most of the other genera included, are known to possess falcifer crura and are quite distinct from those genera bearing radulifer crura.

The following emended definition of Makridin's subfamily Cyclothyridae is therefore proposed :

Costate, costellate, capillate or plicate rhynchonelloids without a septalium ; septum developed or absent, hinge-plates divided, crura radulifer, foramen hypothryd.

This would include the following genera :

Cyclothyris M'Coy, 1844.

Cretirhynchia Pettitt, 1950.

Sulcirhynchia Burri, 1953.

Lamellaerhynchia Burri, 1953.

Plicarostrum Burri, 1953.

Lepidorhynchia Burri, 1956.

Burrirhynchia nov.

RANGE. Cretaceous.

Subfamily CYCLOTHYRIDAE Makridin, 1955 emended

Genus *CYCLOTHYRIS* M'Coy, 1844

1844 *Cyclothyris* M'Coy, p. 103, 150, fig. 29.

1852 *Cyclothyris* Davidson, p. 93.

1877 *Cyclothyris* Dall, p. 24.

1906 *Cyclothyris* Buckman, p. 18.

1913 *Cyclothyris* Schuchert in Zittel, p. 398.

1918 *Cyclothyris* Buckman, pl. 14, fig. 1a.

TYPE-SPECIES (by subsequent designation, Buckman, 1906). *Terebratula latissima* J. de C. Sowerby.

EMENDED DIAGNOSIS. Medium to large biconvex rhynchonellidae, oval to subtriangular in outline. Shell multicostate, costae sharp, coarse to fine, subangular to rounded. Growth-lines lamellar to step-like. Anterior commissure uniplicate. Beak-ridges usually distinct, interarea well defined. Foramen medium to large, circular. Deltoidal plates conjunct, cyclothyrid.

Internal characters. Umbonal cavities oval in cross-section. Denticulae well developed. Teeth large, deeply inserted. Dental lamellae strong, subparallel. Hinge-plates broad, slightly arched in transverse section, divided terminally. Crura anteriorly concave.

DESCRIPTION. *Cyclothyris* comprises a very variable group of medium to large rhynchonellidae. With the exception of perhaps one or two species, the outline is distinctly transversely oval. A fold and sulcus develop late and there is usually considerable lateral and anterior thickening of the margins in the gerontic stage. The ornament consists chiefly of strong costae with marked growth-lines sometimes becoming lamellar. The type and position on the valves of the growth-lines is regarded as a specific character and can be linked with type of costation when grouping the species. The members of the *latissima* group, for instance, have numerous subangular or rounded radiating costae with fairly distinct growth-lines at about one-third the distance from the umbo, and approximately three to five at about two-thirds the distance from the umbo. They tend to be closer together or more lamellar and less prominent at the anterior margin. Bifurcation of the costae in adult forms is rare.

In some species, notably *C. antidichotoma* (Buvignier), the ornament shows considerable deviation from the typical. Davidson (1851, pl. 14) in the species *Capillirhynchia wrighti* (Davidson) from the Inferior Oolite, and Ager (1958:69) in *Furcirhynchia furcata* Buckman from the Lias illustrated a similar kind of ornament. In the genus *Cyclothyris* this type of ornament is regarded as a specific character.

Marked uniplication of the anterior margin is a strong feature but some species show a tendency to produce an asymmetrical commissure. These aberrant forms are noticeable throughout the generic range and particularly in the Cenomanian species *C. difformis*.

Some species, for instance *C. scaldisensis* (d'Archiac), are characterized by their large circular foramen. This is a common feature of the *latissima* group.

Internal characters

Pedicle valve. The umbonal cavity is roughly oval in cross-section, a pedicle collar being developed within the first 4 mm. The cyclothyrid deltidium is seen in transverse section as two outwardly curving plates, one on either side of the foramen. The crenulated hinge-teeth are thick, quadrate and deeply inserted, expanding dorsally. The diductor muscle-scars are large and triangular. The adductor muscle-scars are too faint for adequate description.

Brachial valve. No cardinal process is developed. The hinge-plates are slender and gently arched ventrally. Inner and outer socket-ridges are well defined. The median septum is short and does not support the hinge-plates. Radulifer crura originate from the distal parts of the hinge-plates and curve ventrally. Each terminates in a Y-shaped fork which may be slightly deflected dorsally or remains almost horizontal to the sides of the valve.

DISCUSSION. The chief distinguishing characters of *Cyclothyris*, apart from its general outline, are the extensive interarea, absence of bifurcation and intercalation

of costae in adult forms, large circular foramen and incipient fold in the brachial valve. The arched and divided or forked hinge-plates, as seen in transverse section, distinguish it from other Cretaceous rhynchonellid genera. It is readily distinguished from *Orbirhynchia* (Pettitt, 1954) in possessing radulifer crura.

The stratigraphical zones quoted for species of *Cyclothyris* from the Lower Greensand are according to Casey (1961).

Cyclothyris latissima (J. de C. Sowerby)

(Pl. 4, figs. 7, 8 ; Text-fig. 4)

- 1825 *Terebratula lata* J. de C. Sowerby (*non T. lata* J. Sowerby), p. 165, pl. 502, fig. 1.
 1829 *Terebratula latissima* J. de C. Sowerby, Index.
 1852 *Rhynchonella latissima* (J. de C. Sowerby) : Davidson, p. 82, pl. 11, figs. 15-22.
 1918 *Cyclothyris latissima* (J. de C. Sowerby) : Buckman, p. 14, pl. 14, fig. 1a.
 1950 *Cyclothyris latissima* (J. de C. Sowerby) : Pettitt, pl. 1, figs. 14, 15.
 1956 *Cyclothyris latissima* (J. de C. Sowerby) : Owen, pl. 3, fig. 6.

EMENDED DIAGNOSIS. Medium sized *Cyclothyris* approximately 21 mm. long, 24 mm. wide and 13 mm. thick. Transversely oval to subtriangular in outline, lenticular in anterior contour. Brachial valve convex, with broad, flat almost imperceptible median fold. Pedicle valve less convex, with broad shallow sulcus. Anterior commissure broadly arcuate. Umbo short, thick, slightly incurved. Foramen large. Deltidial plates well exposed. Each valve ornamented by about 60 rounded or subangular costellae (23 per 10 mm.) with approximately 13 on the fold and a corresponding number in the sulcus.

LECTOTYPE. In the original description of the species J. de C. Sowerby (1825 : 165) quotes three localities, Faringdon, Sidmouth, and Devizes Canal. The species is represented in the Sowerby Collection, British Museum (Natural History) by three specimens from the above localities. Of these, the specimen from Faringdon was selected and figured as lectotype of the species by Pettitt (1950, pl. 1). It is registered in the British Museum (Natural History) collections as B.61499. Of the two remaining syntypes, one is recognizable as a young *C. difformis* (Valenciennes in Lamarck) from the Cenomanian of Sidmouth, Devon, while the other is crushed and too badly damaged for identification.

DESCRIPTION. Although *C. latissima* does not seem to show the same range of variation as other species of *Cyclothyris*, a marked variant occurs at Faringdon, Berkshire and at Brickhill, Buckinghamshire and reaches dimensions considerably larger than the typical form, measuring approximately 25 mm. long, 34 mm. wide and 18 mm. thick. The dimensions of the lectotype are 21 mm. long, 28 mm. wide and 12 mm. thick. A fine series of specimens illustrating the above variant are to be found in the collections of the Sedgwick Museum, Cambridge numbered SM. B.25682-B.25708.

The outline of the shell of *C. latissima* remains oval to subtriangular with a broad flat fold on the brachial valve. The ornament consists of approximately 60 costellae on each valve, which are characteristically subangular or rounded and interrupted by step-like or fairly steep concentric growth-lines at about one-third the distance

from the umbo and again at about two-thirds the distance from the umbo. Growth-lines at the anterior margin tend to be more numerous, usually about 3 to 5 and are lamellar.

Internal structure. As for genus. Text-fig. 4.

Cyclothyris latissima can be distinguished from other Aptian species of *Cyclothyris* by its more acutely triangular outline, more extensive interarea, less marked anterior fold and more prominent growth-lines. It differs from *C. depressa* (J. de C. Sowerby)

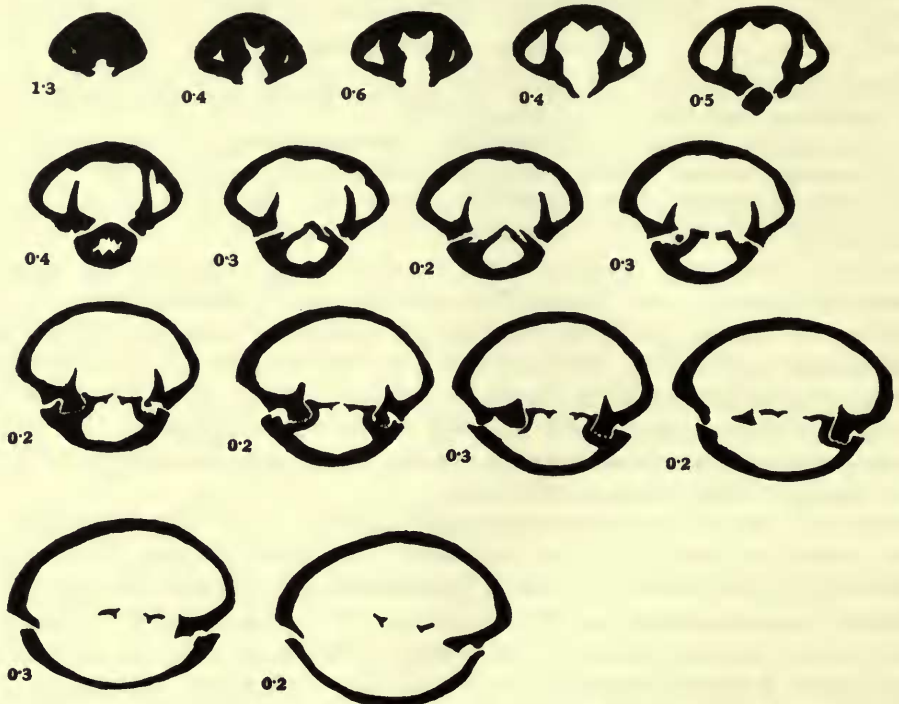


FIG. 4. A series of fifteen transverse serial sections through the umbonal part of a specimen of *Cyclothyris latissima* (J. de C. Sowerby) from the type locality, Faringdon, Berkshire. BM. BB.5482. $\times 2$.

in its less produced beak, larger dimensions, less angular costellae and more arcuate anterior commissure. It is less convex than other *Cyclothyris* species with the exception of *C. scaldisensis* (d'Archiac) from the Tourtia of Belgium which it resembles, but can be distinguished from this species by its smaller dimensions, more prominent growth-lines and less well-developed interarea and beak-ridges.

DISTRIBUTION. Apart from the type locality at Faringdon, Berkshire, where it occurs in the *Tropaeum subarcticum* subzone of the *Parahoplites nutfieldensis* Zone, *C. latissima* has also been found in the *P. nutfieldensis* Zone at Upware, Cambridge and from the junction of the Hythe and Sandgate Beds on the foreshore just west of Folkestone Harbour, Kent.

Cyclothyris antidichotoma (Buvignier)

(Pl. 4, figs. 3-6; Text-figs. 5, 6)

- 1842 *Terebratula antidichotoma* Buvignier, p. 533, pl. 4 fig. 8.
1847 *Rhynchonella antidichotoma* (Buvignier) d'Orbigny, p. 31, pl. 500, figs. 1-5.
1847 *Rhynchonella antidichotoma* (Buvignier) : Pictet & Roux, p. 534, pl. 50, figs. 5a-g.
1872 *Rhynchonella antidichotoma* (Buvignier) : Pictet, p. 41, pl. 199, figs. 13-17b.
1874 *Terebratula antidichotoma* Buvignier : Davidson, p. 65, pl. 8, figs. 19-21.
1903 *Rhynchonella lineolata* var. *mirabilis* Walker, p. 261, pl. 18, figs. 7a-c.

EMENDED DIAGNOSIS. Medium to large biconvex *Cyclothyris* approximately 31 mm. long, 36 mm. wide and 15 mm. thick. Transversely oval to subcircular in outline. Brachial valve with broad, faintly developed median fold. Pedicle valve with wide, shallow sulcus, anteriorly developed. Anterior commissure broadly arcuate to trapezoidal. Umbo massive to sharp, slightly produced. Foramen large. Deltidial plates well exposed. Beak-ridges distinct, interarea extensive. Each valve ornamented with between 15 and 30 fine rounded costellae posteriorly and a few strong angular costae anteriorly.

TYPE SPECIMEN. The original specimen figured by Buvignier (1842, pl. 4, fig. 8) cannot be traced and is presumed lost. It is not proposed to erect a neotype of this species until more material from the type locality has been examined. The only available specimen said to be from the area of the type locality examined by the writer is in the d'Orbigny Collection, Muséum Nationale d'Histoire Naturelle, Paris and is registered in the d'Orbigny catalogue as 6014. This specimen, stated to be from the Albian of Saulce, Ardennes, does not resemble Buvignier's figured specimen in general outline although the ornament is similar. Instead it resembles one of the more robust forms commonly found in England at Brickhill and Upware and regarded as an extreme variant. D'Orbigny (1847, pl. 500) figured two specimens both of which resemble the one figured by Buvignier (1842, pl. 4, fig. 8). Neither of these specimens is in the d'Orbigny Collection and their whereabouts cannot be ascertained.

DESCRIPTION. Buvignier's figure shows a large *Cyclothyris* measuring approximately 32 mm. long and 42 mm. wide, with a sharp beak, large foramen and ornament of fine costellae and strong costae which are the main distinguishing features. Specimens possessing similar features have been examined by the writer from Upware, Cambridgeshire, Brickhill, Buckinghamshire and Potton and Leighton Buzzard, Bedfordshire. In addition collections of specimens also bearing these features from Albian localities in France and Switzerland have been studied in the Muséum d'Histoire Naturelle, Geneva.

It is probable that the original specimen described by Buvignier came from the Gault of Grandpré, although specimens of other species from this locality are usually preserved as internal casts in phosphatized sandy clay. Buvignier's specimen, however, has a well-preserved shell and may have come from the beds below the phosphate workings which are known to be of Upper Aptian age.

In England, the Upper Aptian forms occurring at Brickhill and Upware differ from Buvignier's figured specimen in their more circular general outline and more

convex valves, although variants approaching the typical form have been found. The Lower Albian forms from Leighton Buzzard, while agreeing in general outline and proportions with Buvignier's figure, have a less acute apical angle, less produced beak and smaller interarea and are much nearer a form which occurs at Goudinière, Grand St. Bernard and at Mont Saxonet, Savoie, France. This form is represented



FIG. 5. Eighteen transverse serial sections through the umbonal part of *Cyclothyrus antidichotoma* (Buvignier) from the Upper Aptian, Upware, Cambridge. BM. B.25753. $\times 2$.

in the Davidson Collection, British Museum (Natural History) by three specimens from Goudinière registered as BB.41485-87. Another specimen showing a marked resemblance to the Leighton Buzzard form comes from the Albian of Vergys, Upper Savoie and is registered as BM. B.35284.

Young forms of this species were thought to belong to a new variety by Walker (1903: 261) who described them as *Rhynchonella lineolata* var. *mirabilis*. They are

usually more triangular in outline than the adult forms, with marked anterior sulcation of both valves. The large marginal costae are less numerous at this stage and the median fold in the brachial valve is not developed. Examples of this juvenile stage were figured by Pictet & Roux (1847, pl. 50) and by Pictet (1872, pl. 919) as *R. antidichotoma* (Buvignier).

The ornament of fine costellae and coarse costae running into one another is characteristic of the species but, as already stated, authors have described a similar

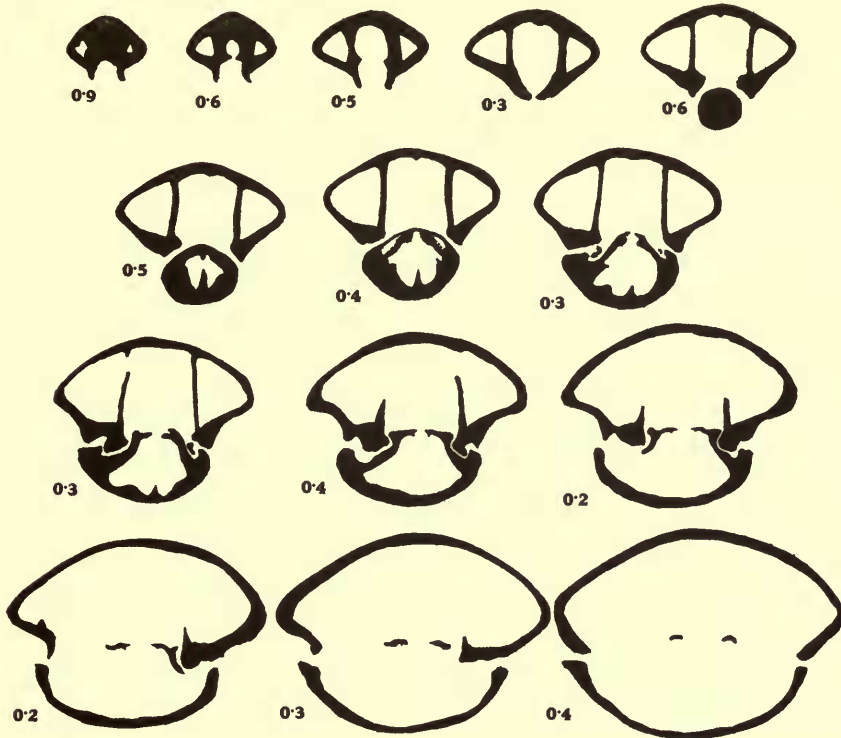


FIG. 6. Fourteen transverse serial sections through the umbonal part of *Cyclothyris antidichotoma* (Buvignier) from the Lower Albian, Shenley Hill, Leighton Buzzard, Bedfordshire. BM. BB.17561. $\times 2$.

feature on species in the Jurassic, and less notably, on Upper Cretaceous species such as *Cretirhynchia octoplicata* (J. Sowerby) as figured by Davidson (1852, pl. 10, figs. I-II).

Although there may be sufficient grounds both morphologically and stratigraphically for separating the Upper Aptian forms from those in the Lower Albian of this country, the writer proposes to leave this extremely well-known species as it is at present interpreted until more material from Grandpré, or at least from the French Ardennes, is available and the limits of variation are possible to define.

DISTRIBUTION. *C. antidichotoma* as at present interpreted is a common fossil in

the Upper Aptian, *P. nutfieldensis* Zone, at Upware, Cambridge and Brickhill, Buckinghamshire and occurs, though not commonly, in the Lower Albian, *Leymeriella tardefurcata* Zone at Leighton Buzzard, Bedfordshire. It has also been collected from the Albian of Mont Saxonet and Goudinière and from the Ardennes, France.

Cyclothyris depressa (J. de C. Sowerby)

(Pl. 4, fig. 11)

1825 *Terebratula depressa* J. de C. Sowerby, p. 165, pl. 502, fig. 3.

1852 *Rhynchonella depressa* (J. de C. Sowerby) Davidson, p. 89, pl. 11, figs. 28-32.

EMENDED DIAGNOSIS. Small *Cyclothyris* about 9 mm. long, 11 mm. wide and 8 mm. thick. Elongate-triangular in outline. Brachial valve convex with moderately well-developed median fold. Pedicle valve less convex with shallow sulcus. Anterior commissure uniplicate with trapezoidal linguiform extension. Beak suberect, apical angle acute. Foramen large. Deltidial plates well exposed. Shell ornamented by about 25-28 sharp, angular, radiating costae originating from the umbones, with 6 on fold and 7-8 in sulcus.

LECTOTYPE. In the original description of the species J. de C. Sowerby (1825) figured two specimens as fig. 3 on his pl. 502. Of these the larger of the two specimens is shown in dorsal and ventral views. This specimen is here selected as lectotype of the species. It is in the Sowerby Collection, British Museum (Natural History) No. B.61468, together with the second figured specimen (B.61469) and three other syntypes (B.61470-72) which are also referable to *C. depressa*.

DESCRIPTION. Apart from its small dimensions, the distinctive characters of this species are those of the beak, which is slightly produced, sharp and suberect. The large circular foramen shows the cyclothyrid deltidial plates to advantage. The pedicle valve has a marked trapezoidal linguiform extension. The sharp, angular costae show no signs of bifurcation or intercalation. They are interrupted only by a faint growth-line which appears at about two-thirds the distance from the umbo to anterior margin.

Internal structure. As for genus.

REMARKS. *C. depressa* has been grouped with *C. schloenbachi* (Davidson) since the two species have much in common. Their general outline and profile is roughly the same with a well-defined fold and sulcus. The linguiform extension is trapezoidal in shape. Both species are relatively small and seem to show the same extremes of variation with fine and coarse costation. *C. depressa*, however, is distinguished from *C. schloenbachi* by its more acutely triangular outline, slightly produced beak and shallower sulcus in the pedicle valve and well-developed fold on the brachial valve. It differs from *C. latissima* in its general triangular outline, angular costation, produced beak, smaller dimensions and trapezoidal linguiform extension.

DISTRIBUTION. *C. depressa* is commonly found in association with *C. latissima* in the Upper Aptian (*P. nutfieldensis* Zone) of Faringdon, Berkshire and also at the same horizon at Brickhill, Buckinghamshire.

Cyclothyris difformis (Valenciennes in Lamarck)

(Pl. 5, figs. 1-7 ; Text-figs. 7, 8)

- 1819 *Terebratula difformis* Valenciennes in Lamarck, p. 255, fig. indicated *Encycl. Meth.*, 1789, pl. 242, fig. 5.
 1821 *Terebratula dimidiata* J. Sowerby, p. 138, pl. 277, fig. 5.
 1822 *Terebratula gallina* Brongniart, p. 84, pl. 9, fig. 2.
 1828 *Terebratula deformis* Lamarck : Defrance, p. 160, pl. 5, fig. 3.
 1847 *Rhynchonella compressa* (Lamarck) : d'Orbigny, p. 35, pl. 497, figs. 1-5.
 1850 *Terebratula difformis* Lamarck : Davidson, p. 433, pl. 15, fig. 48.
 1852 *Terebratula compressa* Lamarck : Davidson, p. 80, pl. 11, figs. 4, 5.
 1885 *Terebratula difformis* Lamarck : Quenstedt, p. 696, pl. 54, fig. 2.
 1900 *Rhynchonella difformis* (Lamarck) Jukes-Browne, p. 65, figs. 41, 42.
 1918 *Terebratula difformis* Valenciennes in Lamarck : Clerc & Favre, pl. 15, fig. 84.

EMENDED DIAGNOSIS. Medium-sized *Cyclothyris* approximately 23 mm. long, 31 mm. wide and 17 mm. thick. Shell biconvex, fold low, indistinct, oval to subtriangular in outline. Anterior commissure with well-marked uniplication. Umbo short, massive, slightly incurved. Foramen fairly large. Deltidial plates conjunct, well exposed. Beak-ridges distinct. Interarea extensive. About 40-45 costae on either valve (14 per 10 mm.) with 9 on fold and 10-11 in sulcus.

LECTOTYPE. Owing to Lamarck's blindness the brachiopods in his "Animaux sans Vertèbres" (vol. 6, 1819) were described by his pupil A. Valenciennes from specimens in Lamarck's own collection. In the description of *Terebratula difformis* (p. 255) Valenciennes indicated a specimen illustrated in *Encyclopédie Méthodique* (1789, pl. 242, fig. 5) quoting the localities "near Le Mans, and also at Cap la Hève, near Le Havre" both Cenomanian localities. No type specimen was named or indicated and the whereabouts of the figured specimen is not known.

Davidson (1850 : 433) in a description of Lamarck's species states that he borrowed the ten specimens used by Valenciennes in his original description and figured one of them as *T. difformis* (pl. 15, fig. 48). This would have served as lectotype of the species had the specimen not been subsequently lost or mislaid. A further specimen figured by Clerc & Favre (1918, pl. 15, figs. 84a-d) has therefore been selected as lectotype of the species. This specimen is one of eight to be found under the name *Terebratula difformis* in the Lamarck Collection at the Muséum d'Histoire Naturelle, Geneva and is registered as No. 48 in the Lamarck catalogue. From the mode of preservation and adhering matrix it was almost certainly collected from the Lower Cenomanian of the Normandy coast. The other seven specimens are probably of Jurassic age. The dimensions of the lectotype are : 23 mm. long, 31 mm. wide and 17 mm. thick.

DESCRIPTION. *C. difformis* is an extremely variable species ranging in outline from subcircular to transversely oval to subtriangular. The ornament usually consists of about 45 coarse to relatively fine costae originating from the umbo of each valve and becoming more elevated towards the anterolateral margins. These costae are usually interrupted by one or two step-like growth-lines situated at about one-half to two-thirds the distance from the umbo to the anterior margin.

The umbo varies from short to massive to slightly produced. An extensive interarea

with distinct beak-ridges is seen throughout the range of variation. The median fold on the brachial valve remains indistinct while the broad, shallow sulcus in the pedicle valve is late in development. The linguiform extension varies from broadly arcuate to trapezoidal but asymmetry of the anterior commissure is a notable character.

Variants worthy of special note occur at Wilmington, south Devon and at Cap la Hève, Normandy. One of the Wilmington varieties departs from the typical in having more convex valves, shorter umbo, smaller foramen and more acutely arched

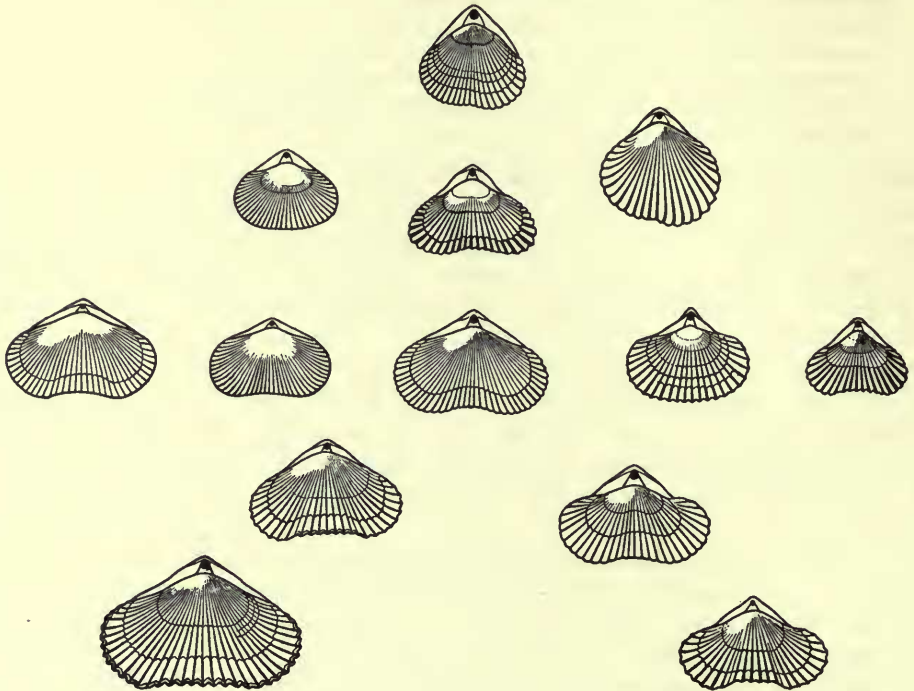


FIG. 7. Diagram illustrating thirteen variants of *Cyclothyris difformis* (Valenciennes in Lamarck) from Wiltshire, south Devonshire, and Normandy.

anterior commissure. The variety usually found on the Normandy coast, on the other hand, has a slightly produced beak, less convex valves and commonly exhibits an asymmetrical anterior commissure.

Another notable variant occurs in the Lower Cenomanian, Tourtia, Belgium. Six well-preserved specimens in the British Museum (Natural History) are numbered BB.41475-80. The same variety occurs in the Lower Cenomanian deposits of Essen, North Germany and is represented in the same museum by a single specimen (BB. 41473).

The specimen figured and described as *Terebratula dimidiata* by J. Sowerby (1821 : 138, pl. 277, fig. 5) from Halldown near Chudleigh, south-east Devon, is a large, almost sphaeroidal rhynchonellid with coarse costae, sharp, produced beak and

asymmetrical anterior commissure. This is either an extreme variant of *C. difformis* or a pathological form.

A form somewhat resembling the outline of Sowerby's *T. dimidiata* but with finer costae, is figured by d'Orbigny (1847, pl. 498, figs. 6-9) from the Charentes as *Rhynchonella difformis*. Some authors have followed d'Orbigny's interpretation of Lamarck's species and Mlle G. Fage (1935: 433, pl. 11), in a description of some Upper Cretaceous rhynchonellids from the Charentes, illustrated an evolutionary development from *R. difformis* d'Orbigny to a variety *R. globata* Fage. Her figured specimen of *R. difformis* is stated to have been collected from the Coniacian.

A specimen figured by J. de C. Sowerby (1836, pl. 18, fig. 2) as *T. dilatata* was stated in the explanation of the plates to have been collected from Blackdown, south Dorset.

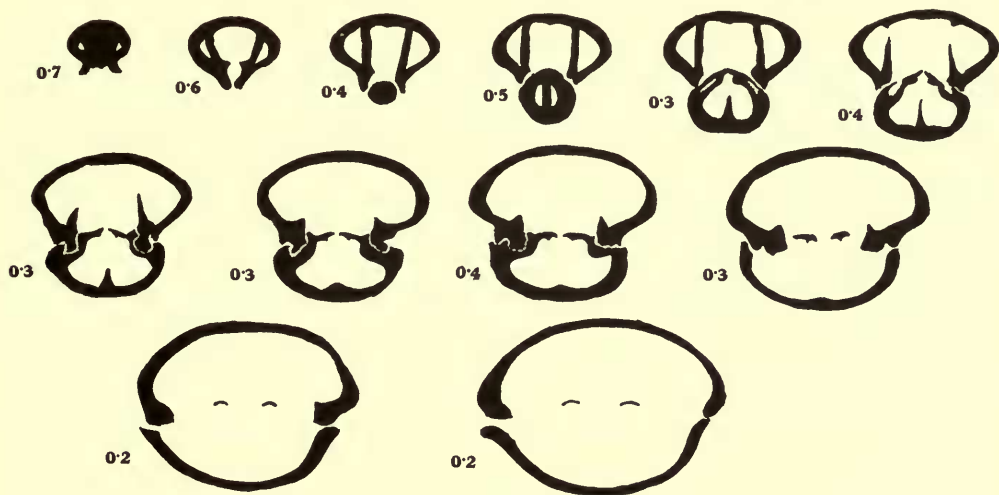


FIG. 8. A series of twelve transverse serial sections through the umbonal part of *Cyclothyrus difformis* (Valenciennes in Lamarck) from the lower Cenomanian, Cap la Hève, near Le Havre, Normandy. BM. B.35224. $\times 2$.

This figure shows a remarkable similarity to a specimen figured by Schloenbach (1867, pl. 23, fig. 2) as *C. difformis* from the Lower Cenomanian of Essen, Germany.

DISTRIBUTION. *C. difformis* ranges from the Lower to Middle Cenomanian of the west of England, Normandy and North Germany. In the type area of the Normandy coast it occurs in the remanié bed at the base of the Cenomanian, is abundant in the Lower Cenomanian and is less common, but still well represented in the Middle Cenomanian.

In England the species is almost unrepresented in the Middle Cenomanian though rare examples have been found in the Middle Cenomanian basement beds of west Dorset. It is abundant, however, in the Lower Cenomanian, occurring in Wiltshire (Warminster Greensand) and the Devon coast, as well as in the Isle of Wight. A well-marked variant is the commonest brachiopod in the sandy Lower Cenomanian

of Wilmington, south Devon. It is said to occur in the *dispar* Zone at Punfield Cove, south Dorset but specimens of this species are more likely to have been collected from the bottom Cenomanian beds. Its occurrence below this level is uncertain.

Cyclothyris compressa (Valenciennes in Lamarck)

(Pl. 5, fig. 8)

1819 *Terebratula compressa* Valenciennes in Lamarck, p. 256, No. 54.

1850 *Terebratula compressa* Lamarck : Davidson, p. 455, pl. 15, fig. 54.

1918 *Terebratula compressa* Valenciennes in Lamarck : Clerc & Favre, pl. 19, figs. 117, 119.

EMENDED DIAGNOSIS. *Cyclothyris*, about 28 mm. long, 32 mm. wide and 14 mm. thick. Distinctly subtriangular in general outline ; brachial valve convex with faint median fold. Pedicle valve posteriorly convex with broad, shallow median sulcus. Both valves ornamented by about 40 strong, acutely angular, radiating costae, (8 per 10 mm.) with 8 on fold and a corresponding number in sulcus. Concentric growth-lines very faint. Beak short, slender, slightly incurved. Beak-ridges distinct, interarea small. Deltidial plates triangular, foramen small.

LECTOTYPE. The specimen here selected as lectotype of the species is one of four syntypes in the Lamarck Collection at the Muséum d'Histoire Naturelle, Geneva and is numbered in the Lamarck Catalogue as No. 54. The specimen was figured by Davidson (1850, pl. 15, fig. 54) and by Clerc & Favre (1918, pl. 19, fig. 117). It was collected from the Upper Cenomanian of Coulaines near Le Mans in the Sarthe, south-west of the Paris basin. The dimensions of the lectotype are : 29 mm. long, 35 mm. wide and 14 mm. thick.

DESCRIPTION. *C. compressa* is one of the most distinctive species of *Cyclothyris*. It is characterized by its acutely subtriangular outline and strong angular costae. It can be distinguished by its low, faintly developed median fold, trapezoidal linguiform extension, and marginal thickening of the valves. It is probable that this species is a direct development of *C. difformis*. A specimen from the Tourtia of Belgium, showing characters of both species is in the British Museum (Natural History) numbered BM. B.1889. Another specimen figured by Davidson (1852, pl. 11, figs. 4, 5) as *C. compressa* and figured here on Pl. 5, fig. 8 as *C. difformis* shows the general outline of *C. difformis* with the anterior and lateral contours and sharp angular costae of *C. compressa* but without the marginal thickening of the valves.

DISTRIBUTION. The species, originally described from Coulaines near Le Mans in the Sarthe, France is confined to the sandy Cenomanian of the south-west Paris basin. The typical form is characteristic of the Upper Cenomanian, Sables du Perche, where it is the only rhynchonellid present. Related but not identical forms occur in the beds above (Marnes à *Ostrea biauriculata*) and below (Sables et Grès du Mans).

Varieties, stated to belong to this species, were described by Cayeux (1949) from Le Havre but were not accompanied by any adequate description or illustration, nor were any type-specimens indicated.

Cyclothyris schloenbachi (Davidson)

(Pl. 4, figs. 12, 13)

1852 *Rhynchonella depressa* vars. A and B, Davidson, p. 92, pl. 12, figs. 28-30.1874 *Rhynchonella schloenbachi* Davidson, p. 59.

EMENDED DIAGNOSIS. Small *Cyclothyris* about 11 mm. long, 15 mm. wide and 13 mm thick. Shell outline oval, brachial valve convex, slightly inflated, with well-defined median fold. Pedicle valve less convex with shallow sulcus broadening anteriorly. Foramen medium sized to small. Beak-ridges distinct, interarea fairly long. Ornament varying from fine to coarse costae.

LECTOTYPE. *C. schloenbachi* was first described by Davidson (1874 : 59) who included three specimens which he had previously described and figured (1852 : 92, pl. 12, figs. 28-30) as varieties A and B of *Rhynchonella depressa* (J. de C. Sowerby), an Upper Aptian species. Two of these specimens (figs. 28, 29) were collected from the Cenomanian of Chardstock, Somerset, BM. B.8215, and the third (fig. 30) from the Cenomanian of Shaftesbury, Wiltshire. Of these syntypes, the specimen from Shaftesbury (BM. B.8216), figured by Davidson (1852, pl. 12, fig. 30) is here selected as lectotype of the species.

DESCRIPTION. *Cyclothyris schloenbachi* is a common fossil in the Lower Cenomanian beds of south Devon, Somerset, south Wiltshire, and Dorset. As can be seen from Davidson's original figures (1852, pl. 12, figs. 28-30) the ornament varies from fine, subangular to strong, coarse costae. Davidson himself (1874 : 59) noted this variation and stated that intermediate forms were commonly found with the extreme forms.

The median fold is better developed or more distinct on specimens with finer costae and is often replaced in the coarser costate forms by a slight sulcation of the brachial valve.

Bifurcation of the costae is a fairly common feature of the young coarsely costate forms. Both variants occur with intermediate forms in the same beds at Chardstock in Somerset, Beer Head, Devon, and Pinhay Cliff, Dorset.

Because of its comparatively small dimensions *C. schloenbachi* cannot easily be confused with other known *Cyclothyris* species. It is distinguished from the somewhat similar *C. depressa* by its oval outline, less produced beak, smaller foramen and better developed or deeper sulcus in the pedicle valve.

DISTRIBUTION. In England, *C. schloenbachi* appears to be confined to the Lower Cenomanian beds of south Devon, Dorset, Somerset and Wiltshire. A slightly larger form of the same species occurs in the Lower Cenomanian beds of Vivautier in the department of Orne, France and is represented in the Davidson Collection, British Museum (Natural History) by fifteen specimens numbered B.11917. These specimens show variations identical with those of the English forms.

Cyclothyris lepida sp. n.

(Pl. 4, fig. 10)

DIAGNOSIS. *Cyclothyris* about 22 mm. long, 32 mm. wide and 16 mm. thick. Shell biconvex, transversely oval in outline. Brachial valve with poorly developed median

fold. Pedicle valve with broad shallow sulcus. Both valves ornamented by about 60–65 fine rounded costellae (21 per 10 mm.) with 20 on the fold and about 22 in the sulcus. Anterior contour lenticular. Linguiform extension trapezoidal, moderately developed. Beak prominent with large foramen.

HOLOTYPE. SM. B.25683 from the Upper Aptian, Brickhill, Buckinghamshire in the collections of the Sedgwick Museum, Cambridge.

Dimensions of holotype. 26 mm. long, 33 mm. wide and 16 mm. thick.

PARATYPES. Twenty-two specimens from the type locality in the Sedgwick Museum SM. B.25682, B.25684–87, B.25689–702, B.25706–08. Also 40 specimens from the same locality and horizon in the British Museum (Natural History), B.25546, B.25547, B.25549.

DESCRIPTION. *C. lepida* is a medium-sized *Cyclothyris* with a characteristic ornament of fine radiating costellae originating from the umbones of each valve. The absence of any prominent growth-lines gives the species a neat appearance. The beak is strong and slightly incurved. An extensive interarea is bounded by distinct beak-ridges. The foramen is large and the deltidial plates well exposed.

Internal characters. As for genus.

REMARKS. This species can be distinguished from others of *Cyclothyris* mainly by its distinctly oval outline, fine costellae, regular anterior commissure, moderately developed but well-marked median fold on the brachial valve, trapezoidal linguiform extension and absence of marked growth-lines. It occurs with *C. antidichotoma* (Buvignier) at Brickhill but its ornament shows none of the characteristics of this species. It is probably the species referred to by authors as *Rhynchonella lata* d'Orbigny (1847 : 21) from the Neocomian of France.

Because of its regular outline, well-marked median fold and absence of prominent growth-lines, *C. lepida* is grouped with *C. depressa* and *C. schloenbachi*.

DISTRIBUTION. *C. lepida* appears to be confined to the Upper Aptian of Brickhill, Buckinghamshire.

Cyclothyris levis sp. n.

(Pl. 4, fig. 9)

DIAGNOSIS. *Cyclothyris* about 20 mm. long, 24 mm. wide and 12 mm. thick. Shell biconvex, distinctly subtriangular in outline. No median fold developed on brachial valve. Shallow, broad sulcus developed anteriorly in pedicle valve. Both valves covered by about 100 very fine capillae (48 per 10 mm.). Beak short, massive, foramen small. Beak-ridges distinct. Interarea small. Deltidial plates not well exposed.

HOLOTYPE. BB.41493 in British Museum (Natural History) from the Lower Albian (*L. tardefurcata* Zone) of the Shenley Limestone, Leighton Buzzard, Bedfordshire. Dimensions of holotype are : 22 mm. long, 27 mm. wide and 14 mm. thick.

PARATYPES. Sixty-one specimens in British Museum (Natural History) registered Nos. B.26541, B.26542, B.26595 . .

DESCRIPTION. In general outline this species resembles *C. latissima* but has a much more inflated brachial valve. A broad, shallow sulcus develops late in the

pedicle valve giving rise to a low broadly arcuate anterior commissure. The short, slightly incurved beak is sharp and massive with a small circular foramen. Distinct beak-ridges define a small interarea. Faint concentric growth-lines are seen on both valves and appear more distinct towards the anterolateral margins.

Internal characters. As for genus.

REMARKS. *C. levis* is distinguished from other *Cyclothyris* species by its extremely fine, rounded capillae, short massive beak, absence of median fold in the brachial valve and poorly developed sulcus in the pedicle valve. It can be distinguished from *C. lepida* sp. n. mainly by its general subtriangular outline, fine capillae, absence of median fold, shorter more massive beak, less extensive interarea, poorly exposed deltidial plates and broad arcuate anterior commissure. Although resembling *C. latissima* in general outline it can be distinguished from this species by its less extensive interarea, less produced beak, finer ornament of capillae, less marked growth-lines and broader arcuate anterior commissure.

DISTRIBUTION. *Cyclothyris levis* is confined to the Lower Albian and is a common fossil in the limestone lenticles (*L. tardefurcata* Zone) at Leighton Buzzard, Bedfordshire.

Cyclothyris scaldisensis (d'Archiac)

(Pl. 4 fig. 1)

1846 *Terebratula scaldisensis* d'Archiac, p. 330, pl. 21, fig. 11.

EMENDED DIAGNOSIS. *Cyclothyris* about 24 mm. long, 32 mm. wide and 16 mm. thick. Shell biconvex, oval to subtriangular in outline, brachial valve with broad incipient median fold. Broad flattened median sulcus in pedicle valve. Umbo short, massive, slightly incurved. Foramen large, circular. Deltidial plates well exposed. Costae fine, rounded, numbering about 68 on each valve (12 per 10 mm.) with 15–18 on the fold and a corresponding number in the sulcus.

HOLOTYPE. The specimen used by d'Archiac in his description of the species was stated to have been collected from the Tourtia of Belgium. It is not certain whether this specimen is still extant and enquiries are still being made. Several well-preserved specimens from the Tourtia of Belgium are to be found in the Davidson Collection and in the general collections of the British Museum (Natural History). Two good examples of this species are from Tournai and are registered B.1889, BB.41492. Another specimen, larger than the dimensions given for the typical form, is figured here on Pl. 4, fig. 1.

DESCRIPTION. *C. scaldisensis* is medium sized, characteristically oval to broadly subtriangular in outline. The brachial valve is convex and slightly inflated posteriorly with a very faintly developed median fold. The pedicle valve is convex in the umbonal region but develops a shallow sulcus which broadens anteriorly. The linguiform extension is moderately developed giving rise to a low broad, arcuate anterior commissure. Both valves are ornamented by about 65–68 fairly fine, rounded costae radiating from the umbones. Faint lamellar growth-lines are seen at about half and again at two-thirds the distance from the beak to the anterior margin. They tend to become more prominent anteriorly. The short umbo is massive with a large circular

foramen and well-exposed deltidial plates. The beak-ridges are distinct and define a faintly concave extensive interarea.

This is probably the least variable of all species of *Cyclothyris*. Its characteristically fine, rounded costae and faint concentric growth-lines make it easily distinguishable from *C. difformis*, with which it is often associated. It differs from *C. latissima*, from which it was most probably developed, by its less prominent growth-lines, longer or more extensive interarea and less incurved beak.

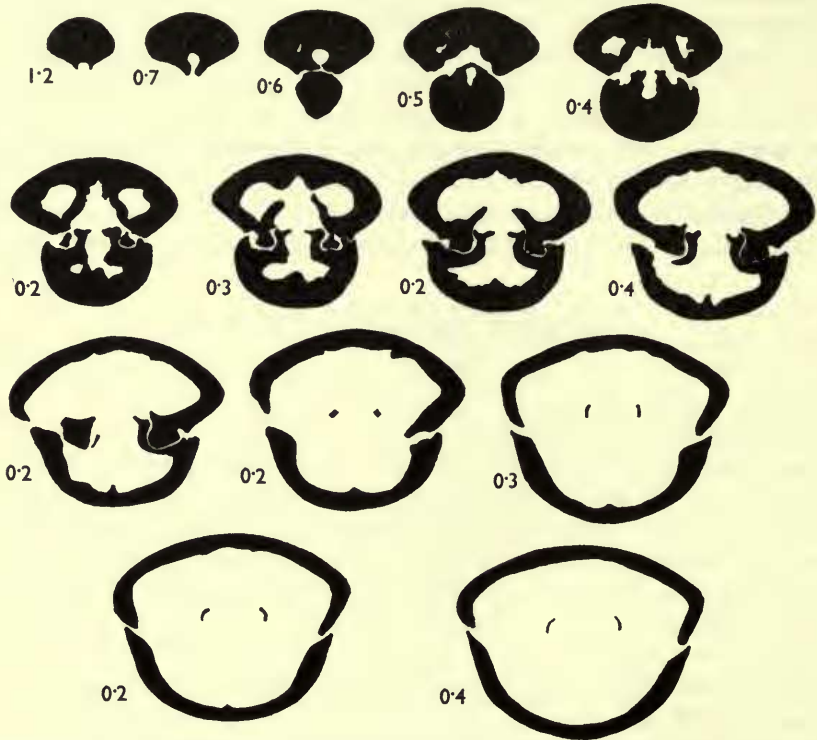


FIG. 9. Fourteen transverse serial sections through the umbonal part of *Cretirhynchia norvicensis* Pettitt from the Upper Chalk (*mucronata* Zone), Mousehold Pit, Norwich. BM. B.25079. $\times 2$.

DISTRIBUTION. Apart from the area of its original description in the Lower Cenomanian, Tourtia, of Belgium, the species is recorded from the Lower Cenomanian of Honfleur, Cap la Hève and Fécamp, Normandy and from a similar horizon in the Munster basin at Essen, Germany. It also occurs, though not commonly, in the Lower Cenomanian beds of Wiltshire, and the south Devon coast.

Genus *BURRIRHYNCHIA* nov.

DIAGNOSIS. Small to medium biconvex rhynchonellidae. Usually elongate-triangular in general outline. Umbo massive, suberect; beak-ridges rounded.

Foramen small, circular, hypothyrid. Deltidial plates disjunct, cyclothyrid. Anterior commissure with broad trapezoidal linguiform extension. Faint fold on brachial valve. Hinge plates narrow, ventrally arched. Median septum strong, persistent. Ornament of fine, rounded costellae (more than 50 on each valve).

TYPE SPECIES. "*Rhynchonella*" *leightonensis* Walker, 1903.

HOLOTYPE. From Lower Albian (*L. tardefurcata* Zone), Shenley Hill, Leighton Buzzard, Bedfordshire, No. GSM. 51279 in the Geological Survey Museum.

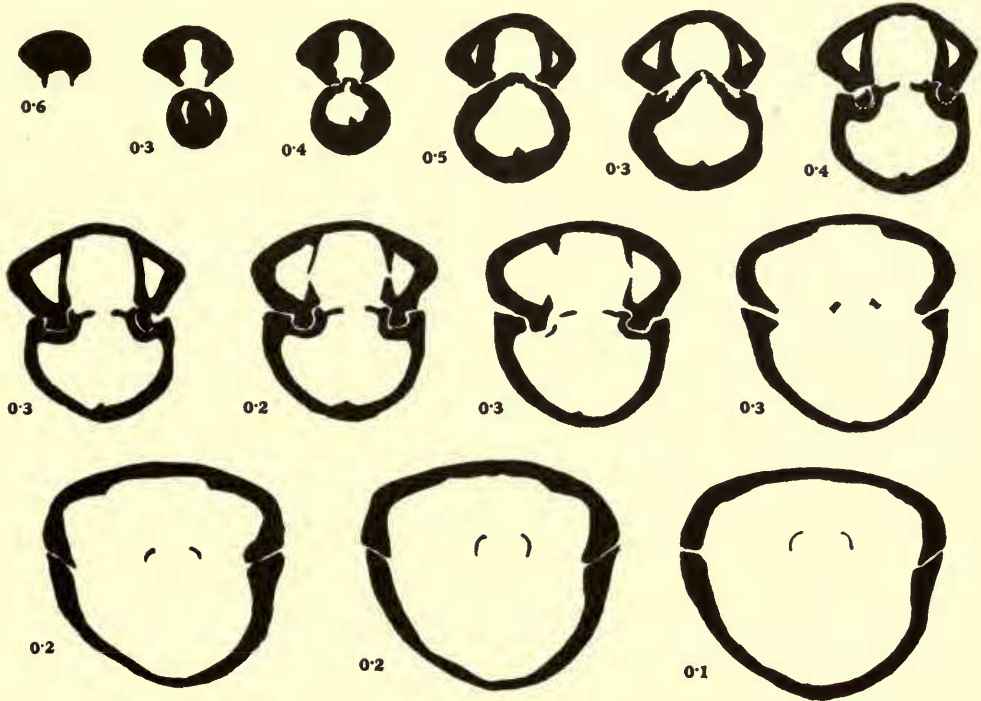


FIG. 10. A series of thirteen serial sections through the umbonal part of *Burrirhynchia cantabrigensis* (Davidson) from the Upper Aptian of Upware, Cambridge. B.M. B.25749. $\times 2$.

REMARKS. The genus differs from *Cyclothyris* in its more elongate-triangular outline, strong persistent median septum, small foramen, rounded beak-ridges, and narrow hinge-plates which are not terminally divided. In transverse outline it resembles *Sulcirhynchia* Burri (1953) from the Swiss Neocomian, from which it may have been developed. It can be distinguished from this genus, however, by its stronger, more persistent, median septum, narrower, less acutely ventrally deflected hinge-plates, shorter, less deeply inserted hinge-teeth and more clearly defined inner and outer socket-ridges.

Burrirhynchia almost certainly gave rise to *Cretirhynchia* Pettitt, 1950, from the Upper Chalk but is distinguished from it by its subparallel dental lamellae, disjunct

deltidial plates, poorly defined interarea and absence of bifurcation of costellae and thicker, less clearly defined hinge-plates.

RANGE. Upper Aptian to Lower Albian.

SPECIES ASSIGNED. "*R.*" *leightonensis* Walker, "*R.*" *cantabrigensis* Davidson, "*R.*" *gibbsiana* (J. de C. Sowerby), "*R.*" *bertheloti* d'Orbigny. "*R.*" *tripartita* Pictet.

MATERIAL AND LOCALITIES. One hundred and sixty specimens of *B. leightonensis* (Walker) from the Lower Albian (*L. tardefurcata* Zone), Shenley Hill, Leighton Buzzard, Bedfordshire (B.26524-28, B.26595), 57 specimens of *B. cantabrigensis* (Davidson) from the Upper Aptian, of Upware, Cambridge and 85 specimens of the same species from Brickhill, Buckinghamshire and one specimen of "*R.*" *gibbsiana* (J. de C. Sow.) from Folkestone, Kent, all in the British Museum (Natural History).

CONCLUSION

Although, externally, *Cyclothyris* shows considerable variation both in size, outline and ornament, internally it remains fairly constant. Within certain limits internal variation can be confined to the development of the hinge-plates, dental lamellae and the septum in the brachial valve. In the typical form from the Upper Aptian the dental lamellae are postero-anteriorly shorter than those of the Albian and Cenomanian forms and the hinge-plates in the Upper Aptian and Albian forms tend to be more acutely deflected towards the ventral valve than in the Cenomanian species, though this may be a variable character.

Some authors, such as Makridin (1955) and Dacqué (1934) have suggested that the genus ranges from the Upper Jurassic to Cretaceous. Their definition of the genus is most probably based on Central European material which may have contained early ancestral forms.

The Neocomian genus *Lepidorhynchia* Burri (1956) certainly has both external and internal characters in common with *Cyclothyris*. The cyclothyrid deltidial plates are already evident and the ornament of subangular costae shows a tendency to marginal dichotomy, a character observed in very young specimens of *C. latissima* from Faringdon. Also, in *Lepidorhynchia*, are seen the ventrally curved and terminally divided hinge-plates which, when further developed in *Cyclothyris*, form the main distinguishing characters allowing the genus to be separated from *Sulcirhynchia* and *Lamellaerhynchia*. Both these genera, however, have a great deal in common with *Cyclothyris* and have obviously been developed from the same original stock.

It was at first thought that *Cyclothyris* gave rise to the Upper Cretaceous genus *Cretirhynchia* but, in the light of present knowledge, this theory is no longer tenable. In his description of the genus *Cretirhynchia*, Pettitt (1950) remarked on the differences between his genus from the Upper Chalk, and the Lower Cretaceous genus *Cyclothyris*. In the same work (p. 11, text-fig. 4) he figured a series of serial sections of the type-species *C. plicatilis* (J. Sowerby) from Northfleet, Kent showing the strong converging dental lamellae, short hinge-plates persistent septum and broad radulifer crura. Recently, the writer, has prepared several serial sections of other species of *Cretirhynchia* from Norfolk and Kent which compare favourably with Pettitt's illustrations. These sections show quite clearly that *Cretirhynchia* is not a direct development of

Cyclothyris but is closely related to early Cretaceous forms represented by the species "*Rhynchonella*" *cantabrigensis* Davidson from Upware and Brickhill and "*R.*" *leightonensis* Walker from the Shenley Limestone. Both these species are here referred to *Burrirhynchia* gen. nov.

A comparison between the serial sections of *Burrirhynchia cantabrigensis* from Upware (Text-fig. 10) and *Cretirhynchia norvicensis* Pettitt from Norfolk (Text-fig. 9) shows that the two have much in common. Neither species has a pedicle collar; the outline in transverse section is similar; both have narrow thickened hinge-plates. The median septum in the brachial valve of both forms persists for well over one half the length of the shell. In addition the broad radulifer crura are given off dorsally from similarly shaped crural bases. Externally also the two forms are much alike. Both have a short, massive umbo with small foramen and ornament of fine, rounded costae. Neither species shows any of the distinguishing characters of *Cyclothyris* nor is there any tendency to asymmetry of the anterior margin, a common feature of some *Cyclothyris* species.

It is probable, therefore, that *Cretirhynchia* developed from such early Cretaceous forms as *Burrirhynchia cantabrigensis* and *B. leightonensis* which marked the beginning or early stages and *C. norvicensis* the last or later stages of its evolution. Both *B. cantabrigensis* and *B. leightonensis* are closely related to *Sulcirhynchia* Burri, from the Neocomian of Switzerland.

Cyclothyris probably died out in the Upper Cenomanian with *C. compressa* (Valenciennes in Lamarck), though Turonian species such as "*Rhynchonella*" *vespertilio* (Brocchi) which may have been developed from *C. compressa* and "*R.*" *elegans* Hanstein, from the Ciplly Chalk, have still to be investigated.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. E. I. White, F.R.S., Keeper of Palaeontology, British Museum (Natural History) for permission to work on the collections in his department and to Dr. H. M. Muir-Wood for her kind help and encouragement, and for reading the manuscript.

My thanks are also due to Dr. F. Burri, Basel; to Mme. A. Schnorf, Musée Géologique, Lausanne, Switzerland; to Mr. A. G. Brighton and Dr. Colin Forbes, Sedgwick Museum, Cambridge; to Mr. K. J. Evans, King's College, London and to Dr. W. T. Dean and Mr. F. M. Wonnacott, British Museum (Natural History), London.

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